

Introduction

Fiber lasers producing high energy, nanosecond pulses with variable repetition rates find a multitude of applications in material processing, laser based ranging, distributed sensing and as a pump for optical parametric amplifiers/oscillators (OPA/OPO). Q-switching is a technique to generate such laser pulses by introducing a suitable loss modulator in the laser cavity. In a conventional fiber laser cavity, the lasing wavelength is typically decided by the total loss in the cavity. However, for applications such as OPA/OPO and second harmonic generation, it is desirable to limit the spectral width of the laser output and to have a wavelength tunable feature. We present the results of a wavelength tunable Q-switched fiber laser.

Principle of operation

A typical Q-switched laser in ring cavity configuration is shown in Fig. 1. The gain medium is an Erbium doped fiber (EDF). Acousto-optic modulator (AOM) is used as the intra-cavity loss modulator. The isolator ensures the unidirectional flow of power in the cavity, and the coupler feeds 50% of the power back into the cavity. Wavelength division multiplexer (WDM) is used to combine the signal and the pump to be launched into the gain fiber. The AOM is modulated using a high-speed RF switch. An intra-cavity tunable band-pass filter (TBPF) is used to control the spectral features.

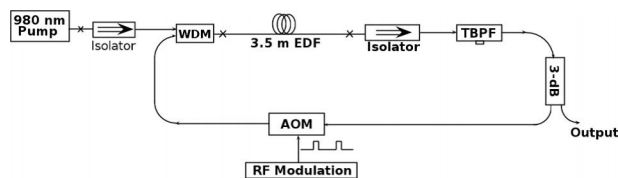


Figure 1. Schematic of the experimental setup of EDF Q-switched laser

Simulation results

Finite difference time domain simulations are carried out for the setup shown in Fig. 1, to establish the wavelength tunability of the laser in entire C-band. The typical time-domain and spectral output is shown in Fig. 2.

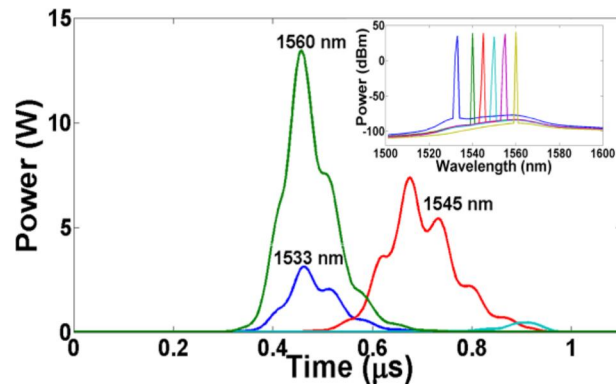


Figure 2. Time-domain output of Q-switched laser when tuned across C-band, corresponding spectrum is shown in the inset.

Experimental results

The laser is initially setup for filter-less operation and Q-switching action is ascertained. The TBPF is now introduced in the cavity. Wavelength tuning from 1530-1565 nm (shown in Fig. 3 (a)) and repetition rate tuning upto 25 kHz is achieved. Stable pulses of width 160 ns and power levels upto 8 W are observed, as shown in Fig. 3 (b).

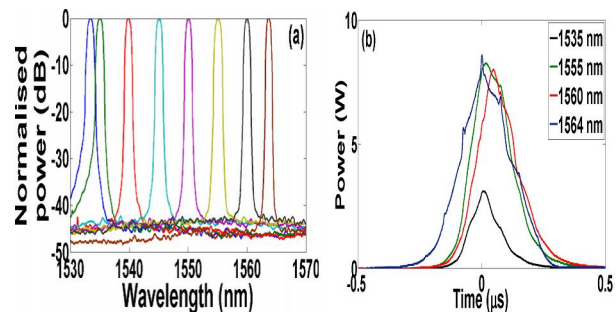


Figure 3. Wavelength tunability of Q-switched laser (b) Pulse shapes for various filter wavelengths at 10 kHz repetition rate.

Conclusion

Wavelength tunable EDF Q-switched laser is designed through numerical simulations and is demonstrated experimentally. Stable pulses of width 160 ns and peak powers upto 8 W, with tunable wavelength (1533 – 1565 nm) and tunable repetition rate (100 Hz- 25 kHz) are achieved.

Publication

M. Srivastava, D. Venkitesh, B. Srinivasan, “Demonstration of a Wavelength Tunable Q-Switched Fiber Laser”, presented at the Asia Communication and Photonics Conf. (ACP), Guangzhou, 2012.